NoiseAssess

Acoustics, Noise and Vibration Consultants

Project:	**Proposed air source heat pump** **St Edmund's Primary School, Heckfield Green, Hoxne, Eye IP21 5AD**
Scope of Report	**Assessment of noise from the proposed air source heat pump**
Client:	Hands-on Mechanical Engineering Ltd
Report Reference:	13782.01.v2 November 2023
Prepared by:	Jack Hutchings BA (Hons) AMIOA
Checked by:	Richard Housley BSc (Hons) MIOA

NoiseAssess Ltd 33 Main Street, Stanton by Dale, Ilkeston DE7 4QH

Tel: 0115 930 5298, Email: richard@noiseassess.co.uk

Also at Sheffield and Chesterfield

Website: noiseassess.co.uk

Registered in England No. 07352339

Registered office 8 Church St, Nottingham NG5 8FB

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1.0 INTRODUCTION

1.1 This noise assessment has been commissioned by Hands-on Mechanical Engineering Ltd to accompany a planning application for the installation of a new air source heat pump (ASHP) St Edmund's Primary School, Heckfield Green, Hoxne, Eye IP21 5AD. The site location is shown on Figure 1.

1.2 The proposed site plan is shown on Figure 2. The ASHP will be located to the east of the site in the playground as shown on Figure 2.

1.3 It is understood that the ASHP will mainly be operational during school hours but may operate outside of school hours to provide frost protection.

1.4 This report relates to the potential impact of the operational noise arising from the proposed ASHP on the closest residential properties located on Chickering Road, Denham Road and Denham Low Road. The report also considers the potential impact of the proposed ASHP on the nearest noise sensitive school rooms.

2.0 CRITERIA

BS4142

2.1 The noise impact of mechanical services on existing residential properties is normally assessed in accordance with BS4142[1].

2.2 The scope of BS4142 is given in the extract below.

"1.1 This standard describes methods for rating and assessing sound of an industrial and/or commercial nature, which includes:

a) Sound from industrial and manufacturing processes;

b) Sound from fixed installations which comprise mechanical and electrical plant and equipment;

c) Sound from the loading and unloading of goods and materials at industrial and / or commercial premises; and

d) Sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train or ship movements on or around an industrial and / or commercial site.

The methods described in this British Standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident."

2.3 The standard compares sound from industrial / commercial sources with the background sound level. The standard states in Clause 9.1 that "Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level". Such features are taken into account by adding a correction to the specific sound level depending on the extent to which the distinguishing acoustic characteristics will attract attention. The standard states the following in Clause 9.2:

"Tonality: For sound ranging from not tonal to prominently tonal the Joint Nordic Method gives a correction of between 0 dB and +6dB for tonality. Subjectively, this can be converted to a penalty of 2 dB for a tone that is just perceptible at the noise receptor, 4 dB where it is clearly perceptible, and 6 dB where it is highly perceptible".

"Impulsivity: A correction of up to 9 dB can be applied for sound that is highly impulsive, considering both the rapidity of the change in sound level and the overall change in sound level. Subjectively, this can be converted to a penalty of 3dB for impulsivity which is just perceptible at the noise receptor, 6 dB where it is clearly perceptible, and 9 dB where it is highly perceptible."

"NOTE 2: If characteristics likely to affect perception and response are present in the specific sound, within the same reference period, then the applicable corrections ought normally to be added arithmetically. However, if and single feature is dominant to the exclusion of the others then it might be appropriate to apply a reduced or even zero correction for the minor characteristics."

"Intermittency: When the specific sound has identifiable on/off conditions, the specific sound level ought to be representative of the time period of length equal to the reference time interval which contains the greatest total amount of on time. This can necessitate measuring the specific sound over a number of shorter sampling periods that are in combination less than the reference time interval in total, and then calculating the specific sound level for the reference time interval allowing for time when the specific sound is not present. If the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied".

"Other sound characteristics: Where the specific sound features characteristics that are neither tonal, nor impulsive, nor intermittent, though otherwise are readily distinctive against the residual acoustic environment, a penalty of 3dB can be applied."

2.4 BS4142 provides guidance on the assessment of impacts in Clause 11.

"11 Assessment of the impacts

COMMENTARY ON CLAUSE 11.

The significance of sound of an industrial / commercial nature depends upon both the margin by which the rating of the specific sound source exceeds the background sound level and the context in which the sound occurs. An effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs / will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context.

Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level, and consider the following:

a) Typically, the greater this difference, the greater the magnitude of the impact.

b) A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context.

c) A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context.

d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context".

2.5 BS4142 recommends that the specific sound level during daytime periods 07:00 – 23:00 hrs should be determined over a reference time interval of 1 hour and during night-time periods 23:00 – 07:00 hrs over a reference time interval of 15 minutes.

Assessment in Context

2.6 BS4142 recommends that the industrial sound should also be assessed in context. Therefore, the sound levels have been assessed in the context of the character of the area; the existing ambient noise levels and the criteria given in BS8233[2].

2.7 The BS8233 recommendations for indoor ambient noise levels are given below.

Table 1: BS8233 recommendations for indoor ambient noise levels

Activity	Location	07:00 to 23:00 hrs	23:00 to 07:00 hrs
Resting	Living room	35 $dBL_{Aeq,16hour}$	-
Dining	Dining room/area	40 $dBL_{Aeq,16hour}$	-
Sleeping (daytime resting)	Bedroom	35 $dBL_{Aeq,16hour}$	30 $dBL_{Aeq,8hour}$

2.8 Paragraph 7.7.3.2 of BS8233 recommends that for traditional external amenity areas such as gardens and patios, it is desirable that during the daytime the external noise level does not exceed 50 $dBL_{Aeq,T}$ with an upper guideline value of 55 $dBL_{Aeq,T}$ which would be acceptable in noisier environments. The time period is not stated but is assumed to be 16 hours (07:00 hours to 23:00 hrs) as in the previous version of BS8233.

BB93, Acoustic Design of Schools: performance standards

2.9 BB93[3] gives guidance on the acoustic performance standards based on room classifications.

2.10 Table 1 of BB93 provides guidance for upper limits for indoor ambient noise levels (IANL) in schools as summarised below. The standards referred to are for new build schools which are more stringent and make the noise assessment conservative.

Table 2. BB93 room classifications and new build indoor ambient noise level (IANL)

Room	BB93 room classification	Upper limit for indoor ambient noise level $dBL_{Aeq,30min}$
Hall	Multi-purpose hall	35
Classroom	Primary school classroom	35

3.0 NOISE SURVEY

3.1 An unattended noise survey was carried out from 14:00 hrs on Wednesday 06/09/2023 to 11:00 hrs on Thursday 07/09/2023. The survey was carried out at noise monitoring location A shown on Figure 1.

3.2 The noise survey was carried out using a Rion NL-52 sound level meter (s/n 00732142). The sound level meter was calibrated using a portable Norsonic 1251 calibrator (s/n 30901) at the start and finish of the survey with no variation in the calibration level. The microphone was at a height of 3m in free field conditions.

3.3 The weather conditions were dry with light winds (<5m/s).

3.4 The results of the noise survey are summarised below and are presented in full in Appendix A2. The measurements were taken over 5-minute sample periods. The L_{A90} values have been arithmetically averaged. Noise levels have been reported for the full daytime period (07:00-23:00 hrs) and for the school day period (07:00-18:00 hrs). Noise levels have also been reported for the full night-time period (23:00-07:00 hrs) and for the night-time period 05:00-07:00 hrs when the client has indicated that the proposed ASHP may be working at its full operational setting.

Table 3. Summary of existing daytime freefield noise levels

Date	Time period	Average dBL_{A90}	Mode dBL_{A90}
Daytime			
06-07/09/2023	14:00-23:00+07:00-11:00	37	39
06-07/09/2023	14:00-18:00+07:00-11:00	41	39
Night-time			
06-07/09/2023	23:00-07:00	27	23
06-07/09/2023	05:00-07:00	34	36

Daytime: 1 hour reference period

Night-time: 15-minute reference period

3.5 The main noise sources on site whilst installing and retrieving the sound level meter were:

- Children in the school yard.
- Road traffic.

4.0 NOISE IMPACT ASSESSMENT AND RECOMMENDATIONS

Proposed ASHP

4.1 The ASHP is to be located at ground level in the playground to the east of the school buildings as shown on Figure 2.

4.2 The calculation of noise from the ASHP has been based on the manufacturer's noise data as provided by the client. The manufacturer's broad-band sound power level has been used in conjunction with the frequency spectrum shown below which has been calculated by adjusting the manufacturer's 1m sound pressure level frequency spectrum to match the broad-band sound power level.

Table 4. Manufacturer's noise data for air source heat pump

	Octave band c.f. Hz (dB,L)								dB,L_{WA}
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	
ASHP: Daikin EWYT135B-SSA1+OP204	90	89	85	84	83	84	77	69	89

4.3 It is understood that:

- The noise data in Table 4 is for the ASHP running at 100% load.
- In normal operation the ASHP will not operate at any more than 75% load.
- When operating in frost protection mode the ASHP will run at 25% load.

4.4 This noise assessment is based on the noise data for the ASHP operating at 100% because there is no noise data for the ASHP operating at lower loads. This noise assessment is therefore conservative.

4.5 The use of the manufacturer's 1m sound pressure levels would give a lower assessment result than the use of the sound power level. It has been assumed that the reason for this discrepancy is that the sound pressure level readings are generally taken in front of the unit and do not include the full sound energy of the unit in cases when the fans are on top and projecting more sound vertically. Therefore, the sound power level has been used to give the worst-case scenario.

Control of noise from ASHP

Acoustic enclosure

4.6 The ASHP is to be fitted with an acoustic enclosure approximately 5.6m (wide) x 3m (deep) x 3m (high) with acoustic louvres in the roof and southeast, southwest and northwest elevations. The final design of the acoustic enclosure is still to be confirmed by a specialist manufacturer. An image showing the type of acoustic enclosure being considered is given in Figure 3.

4.7 Suggested manufacturers for the acoustic enclosure include:

- Caice: 0118 918 6470: http://www.caice.co.uk/
- Wakefield Acoustics, 01924 418940: http://www.wakefieldacoustics.co.uk/
- Allaway Acoustics, 01992 550825: http://www.allawayacoustics.co.uk/

4.8 The minimum insertion loss that should be provided by the acoustic louvres is given below.

Table 5. Acoustic louvres: minimum insertion loss

	Insertion Loss								Rw
	63	125	250	500	1000	2000	4000	8000	
Insertion Loss	6	6	9	13	21	20	16	13	18

4.9 The insertion loss detailed above is based on Caice SS300 acoustic louvres with a depth of 300mm.

4.10 The maximum areas of acoustic louvre in each elevation and the roof should be as follows:

- Roof: 9.6 m^2
- Southeast elevation: ≤ 10.0 m^2
- Southwest elevation: ≤ 8.0 m^2
- Northwest elevation: ≤ 12.3 m^2
- Northeast elevation: ≤ 0 m^2

4.11 It is recommended that the roof and walls of the acoustic enclosure which are not being formed using acoustic louvres should be imperforate and have a minimum mass of 12.5 kg/m^2.

4.12 To reduce the reflection of noise from hard finishes within the enclosure it is recommended that an absorbent lining should be fitted to all the non-louvred sections of the internal walls and the underside of the roof. The absorbent lining could be formed with mineral wool covered with perforated metal sheeting with a minimum 30% open area. Alternatively, proprietary panels could be used such as available from the suggested manufacturers given in 4.7 or:

- Custom Audio Designs: 01730 269572 https://www.customaudiodirect.co.uk/acoustison-perforated-steel-sound-absorber
- Varitone VT-2 from IAC Acoustics: 01962 873000 https://iacacoustics.global/wp-content/uploads/Varitone-Brochure.pdf
- Quietstone: 01625 576970 https://www.quietstone.co.uk/product/acoustic-panels/

Acoustic barrier

4.13 In addition to the proposed acoustic enclosure, it is recommended that the ASHP be surrounded by an acoustic barrier with a minimum height of 2.4m as shown on Figure 4.

4.14 The acoustic barrier should be imperforate and have a minimum mass of 12 kg/m^2. The acoustic barriers should be fully sealed to the ground at the base and should be designed so that gaps do not open between panels or at the base due to weathering over the lifespan of the barrier. This will normally mean that panels are interlocking or have cover strips and that gravel boards at the base are designed to limit deterioration due to contact with the ground. Consideration should be given to the procedures for maintenance or replacement of the barriers as necessary to ensure their continued effectiveness. The acoustic barriers may consist of one of the following:

- An acoustic fence meeting the above specification. Acoustic fences are available in various materials with varying lifespans as can be seen from the examples of proprietary acoustic fences below.
- A masonry wall with no gaps.

4.15 Examples of suppliers of proprietary acoustics fences are as follows:

Gramm Barriers:	http://www.grammbarriers.com/our-products/acoustic-barriers/
Jacksons Fencing:	https://www.jacksons-fencing.co.uk/acoustic-fencing
Premier Acoustic Fencing:	http://www.premieracousticfencing.co.uk/

4.16 The barrier may be up to 1.5m from the ASHP on all sides. Any gates in the barrier should have the same mass as the barrier and close onto seals at the edges and to the ground.

4.17 To reduce the reflection of noise from hard finishes the advice given in 4.12 above for the acoustic enclosure can also be applied to the barrier if necessary.

4.18 It is the Client's responsibility to check with the manufacturer that products chosen are suitable for the proposed use in other respects. The sound insulation performance of the proposed construction will be dependent upon correct installation and workmanship.

4.19 The recommendations are given for acoustic reasons only and advice on other matters should be obtained from other specialists. The safety implications of the installation of the recommended products / material should be checked by the Client before use and appropriate systems of work put in place.

5.0 NOISE MODELLING

5.1 Noise from the proposed ASHP with the recommended acoustic enclosure in place has been predicted using CadnaA noise modelling software, produced by DataKustick GmbH. Noise levels have been predicted for:

- R1: A west facing window at the closest residential property on Chickering Road to the east of the school.
- R2: A west facing window at the closest residential property on Denham Road to the southeast of the school.
- R3: A northeast facing window at the closest residential property on Denham Low Road to the south of the school.
- R4: A multi-purpose hall on the southeast elevation of the school.
- R5: A classroom on the southeast elevation of the school.

The receptors are shown on Figure 1.

5.2 Daytime noise at the nearest residential properties has been predicted for a height of 1.5m above ground level representing ground floor windows and private gardens. Night-time noise at the nearest residential properties has been predicted for a height of 4.0m above ground level representing first floor windows.

5.3 Noise at the school has been calculated for a height of 4m above ground level for R4, representing the nearest window to the school hall and a height of 1.5m above ground level for R5 representing a classroom window.

5.4 The noise model has been used to calculate the noise propagation in accordance with ISO 9613-1996: Acoustics[4]. The model takes into account distance attenuation; screening attenuation; ground absorption; atmospheric absorption and reflections. The modelling has been based on hard ground (G=0) and a maximum order of reflection of 1 with a search radius of 100m. The atmospheric conditions used in the model input were a temperature of 10℃ and a relative humidity of 70%. The modelling calculations have been carried out on the basis of the receptor being downwind of all sources simultaneously and no allowance has been made for directivity. This assumption is conservative.

Table 6. Predicted noise levels from ASHP at receptors with enclosure and acoustic barrier

Receptor	Noise level, dBL_{Aeq}	
	Daytime	Night-time
R1: Chickering Road	24	25
R2: Denham Road	22	22
R3: Denham Low Road	20	21
R4: School Hall	29	n/a
R5: Classroom	23	n/a

6.0 BS4142 ASSESSMENT OF NOISE FROM THE ASHP

6.1 The potential noise impact of the new air source heat pump at the nearest residential properties, R1-R3, has been assessed in accordance with BS4142[1].

6.2 It is understood that the proposed ASHP will mainly operate during school hours and very likely in the period just before the school day to pre-heat the school. Noise from the ASHP has been assessed in accordance with BS4142 using the lowest daytime/night-time average or modal dBL_{A90} levels measured during the following periods:

- Daytime: 07:00-23:00 hrs & 07:00-18:00 hrs.
- Night-time: 23:00-07:00 hrs & 05:00-07:00 hrs.

6.3 No tonal penalty has been applied because it is understood that noise from the ASHP will be broadband with no distinct acoustic character. No penalty for impulsivity/intermittency has been applied because it is understood that the unit will run steadily rather than frequently switching on and off.

Table 7. BS4142 assessment of noise from the AHSP at R1

	Daytime		Night-time	
	07:00-23:00	**07:00-18:00**	**23:00-07:00**	**05:00-07:00**
Specific noise level, dBL_{Aeq}	24	24	25	25
Tonal Penalty, dB	0	0	0	0
Impulsive/Intermittency penalty, dB	0	0	0	0
Rating, dB	24	24	25	25
Background noise level, dBL_{A90}	37	39	23	34
Rating - background, dB	**-13**	**-15**	**2**	**-9**

Table 8. BS4142 assessment of noise from the AHSP at R2

	Daytime		Night-time	
	07:00-23:00	**07:00-18:00**	**23:00-07:00**	**05:00-07:00**
Specific noise level, dBL_{Aeq}	22	22	22	22
Tonal Penalty, dB	0	0	0	0
Impulsive/Intermittency penalty, dB	0	0	0	0
Rating, dB	22	22	22	22
Background noise level, dBL_{A90}	37	39	23	34
Rating - background, dB	**-15**	**-17**	**-1**	**-12**

Table 9. BS4142 assessment of noise from the ASHP at R3

	Daytime		Night-time	
	07:00-23:00	**07:00-18:00**	**23:00-07:00**	**05:00-07:00**
Specific noise level, dBL_{Aeq}	20	20	21	21
Tonal Penalty, dB	0	0	0	0
Impulsive/Intermittency penalty, dB	0	0	0	0
Rating, dB	20	20	21	21
Background noise level, dBL_{A90}	37	39	23	34
Rating - background, dB	**-17**	**-19**	**-2**	**-13**

6.4 The results of the BS4142 assessment indicate that:

- There will be a very low noise impact during the full daytime period 07:00-23:00 hrs and during the school day 07:00-18:00 hrs at all receptors.
- There will be a low noise impact during the full night-time period 23:00-07:00 hrs at all receptors.

ASHP noise considered in context

6.5 BS4142 recommends that the noise also be judged in context.

6.6 The predicted noise from the ASHP at the nearest residential properties will be low in absolute terms and the night-time background noise levels used in the BS4142 assessment are very low.

6.7 The proposed ASHP will operate on its highest setting just before the school day starts and during the school day. During the survey noise levels start to increase from 05:00 hrs onwards, probably due increasing road traffic and then during the school day the area is generally busy with road traffic and school activities. The ASHP is understood to have no significant acoustic character so it is expected that the ASHP will have a low noise impact during the periods when it is likely to be operating at a high setting.

6.8 The ASHP is only expected to operate at a low setting to provide frost protection during the quiet periods of the night. If it is running at 25% of load rather the 75% which is to be its highest setting this could possibly result in a noise reduction of up to 6 dB(A). The use of the ASHP during the night-time is only likely to occur during the cold winter months when the nearby residential properties are likely to have their windows closed resulting in a low noise impact on the closest residential properties.

6.9 The predicted noise levels of 20-24 $dBL_{Aeq,1hr}$ during the daytime and 21-25 $dBL_{Aeq,15min}$ at night at the nearest residential properties due to the ASHP operating at 100% speed are low in absolute terms.

- The predicted daytime noise levels will be well below the BS8233 upper limit of 55 $dBL_{Aeq,1hr}$ for daytime noise in private garden areas.
- A façade with an open window is normally assumed to provide sound attenuation of 10-15 dB(A).
  - Internal noise levels due to the break-in of ASHP noise through a partially open window will not greater than 14 dBL_{Aeq} during the daytime which is well below the BS8233 guidance of 35 dBL_{Aeq} in living rooms and bedrooms during the daytime (07:00-23:00 hrs).
  - Internal noise levels due to the break-in of ASHP noise through a partially open window will not greater than 15 dBL_{Aeq} during the night-time which is well below the BS8233 guidance of 30 dBL_{Aeq} in during the night-time (23:00-07:00 hrs).

Summary

6.10 The BS4142 assessment indicates that noise from the proposed ASHP will have a low impact at the nearest residential properties during the full daytime period 07:00-23:00 hrs, the school day 07:00-18:00 hrs and the early morning period 05:00-07:00 hrs when the system may be pre-heating the school.

6.11 The BS4142 assessment indicates that noise from the proposed ASHP will have a low noise impact at all receptors during the full night-time period 23:00-07:00 hrs.

6.12 When considered in context a low noise impact is indicated especially when taking into account that the running speed will be lower in the 23:00-05:00 hrs period and any use of the ASHP during the night-time is only likely to occur during the cold winter months when the nearby residential properties are likely to have their windows closed. When the results of the night-time BS4142 are considered in context it is therefore concluded that proposed ASHP will have a low noise impact during night-time periods.

7.0 ASSESSMENT OF NOISE FROM THE ASHP IN ACCORDANCE WITH BB93

7.1 The break-in of ASHP noise to the school rooms closest to the proposed ASHP has been calculated and compared with the guidance in Table 1 of BB93 for indoor ambient noise levels (IANL). The guidance compared against in Table 1 of BB93 is for new build schools which is more stringent and makes the noise assessment conservative.

7.2 It is understood that there is a multi-purpose hall (R4) and a classroom (R5) that may be subject to noise from the proposed ASHP. Noise break-in to the school rooms has been estimated based on a façade with an open window normally being assumed to provide sound attenuation of 10-15 dB(A). Noise break-in to the nearest school rooms to the proposed ASHP is shown below.

Table 8. Noise levels in nearest school rooms to the ASHP with an open window

Room	External, dBL_{Aeq}	IANL, dBL_{Aeq}	Room criterion, dBL_{Aeq}
R4: School hall	29	14-19	35
R5: Classroom	23	8-13	35

7.3 With the acoustic enclosure and barrier in place, noise break-in from the ASHP to the nearest school rooms will be below the BB93 upper limits for indoor ambient noise levels (IANL) with the windows partially open. No additional measures are required to control the break-in of noise from the ASHP to the school rooms.

8.0 CONCLUSIONS

8.1 A survey of the existing noise levels representative of the closest residential properties has been carried out.

8.2 Recommendations have been made for an acoustic enclosure in combination with an acoustic barrier to control noise emissions from the proposed air source heat pump (ASHP) to be installed at St Edmunds Primary School.

8.3 With the attenuation measures in place the proposed ASHP is expected to have a low noise impact at the nearest residential properties.

8.4 With the acoustic enclosure and barrier in place noise break-in from the ASHP to the closest noise sensitive school rooms will be below the BB93 upper limits for indoor ambient noise level with windows partially open. No additional measures are required to control noise break-in from the ASHP.

8.5 Based on the above noise assessment, it is recommended that planning permission for the ASHP should not be refused on noise grounds.

9.0 REFERENCES

1. BS4142: British Standard 4142:2014+A1:2019, Methods for rating and assessing industrial and commercial sound.

2. BS8233: British Standard 8233, Guidance on sound insulation and noise reduction for buildings, BSI 2014.

3. Building Bulletin 93: February 2015: Acoustic design of schools: performance standards

4. ISO9613-2: Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of Calculation, The International Organisation for Standardisation.

FIGURE 1. LOCATION OF SITE, NOISE SURVEY & RECEPTORS

FIGURE 2. PROPOSED ASHP LOCATION

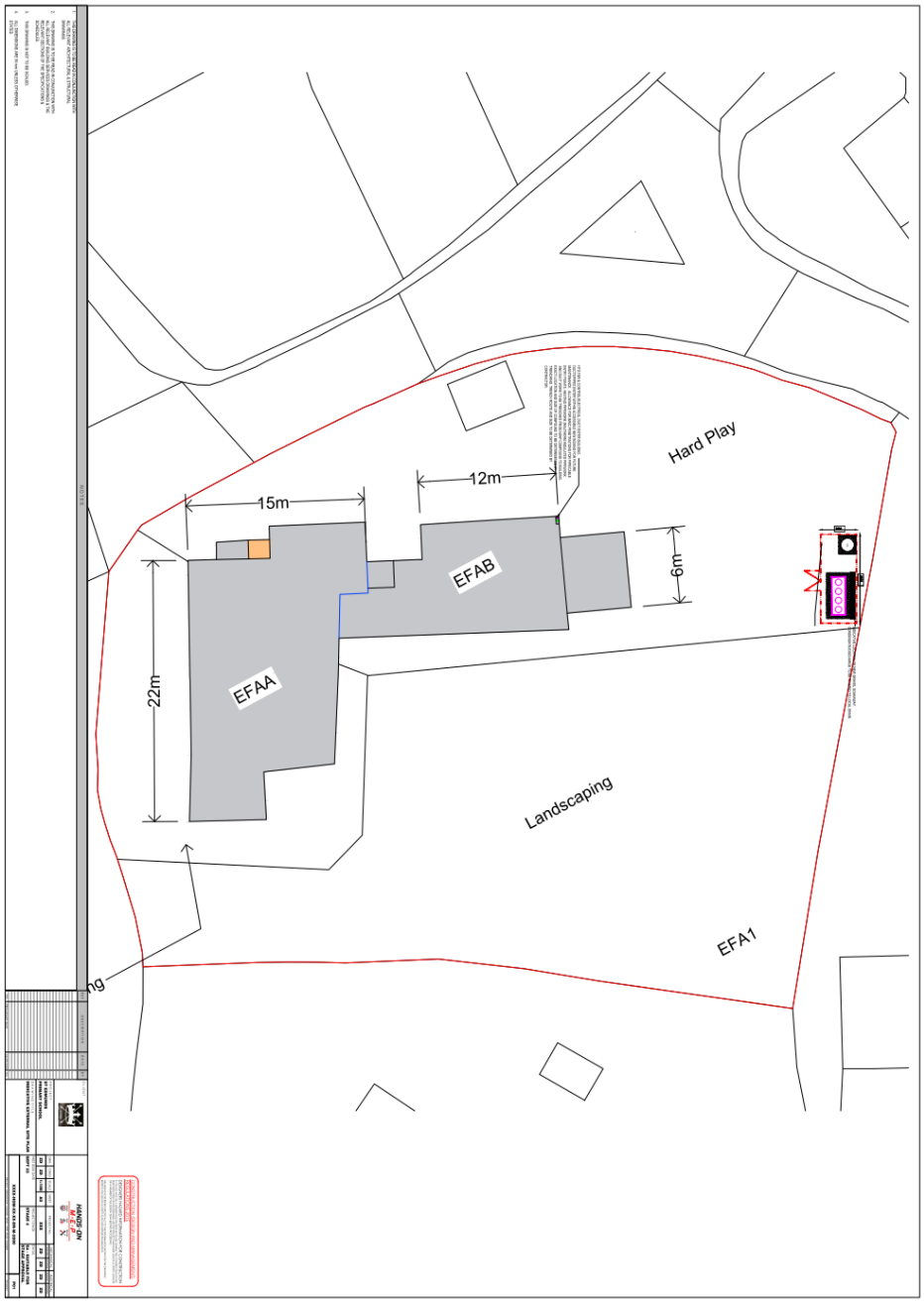
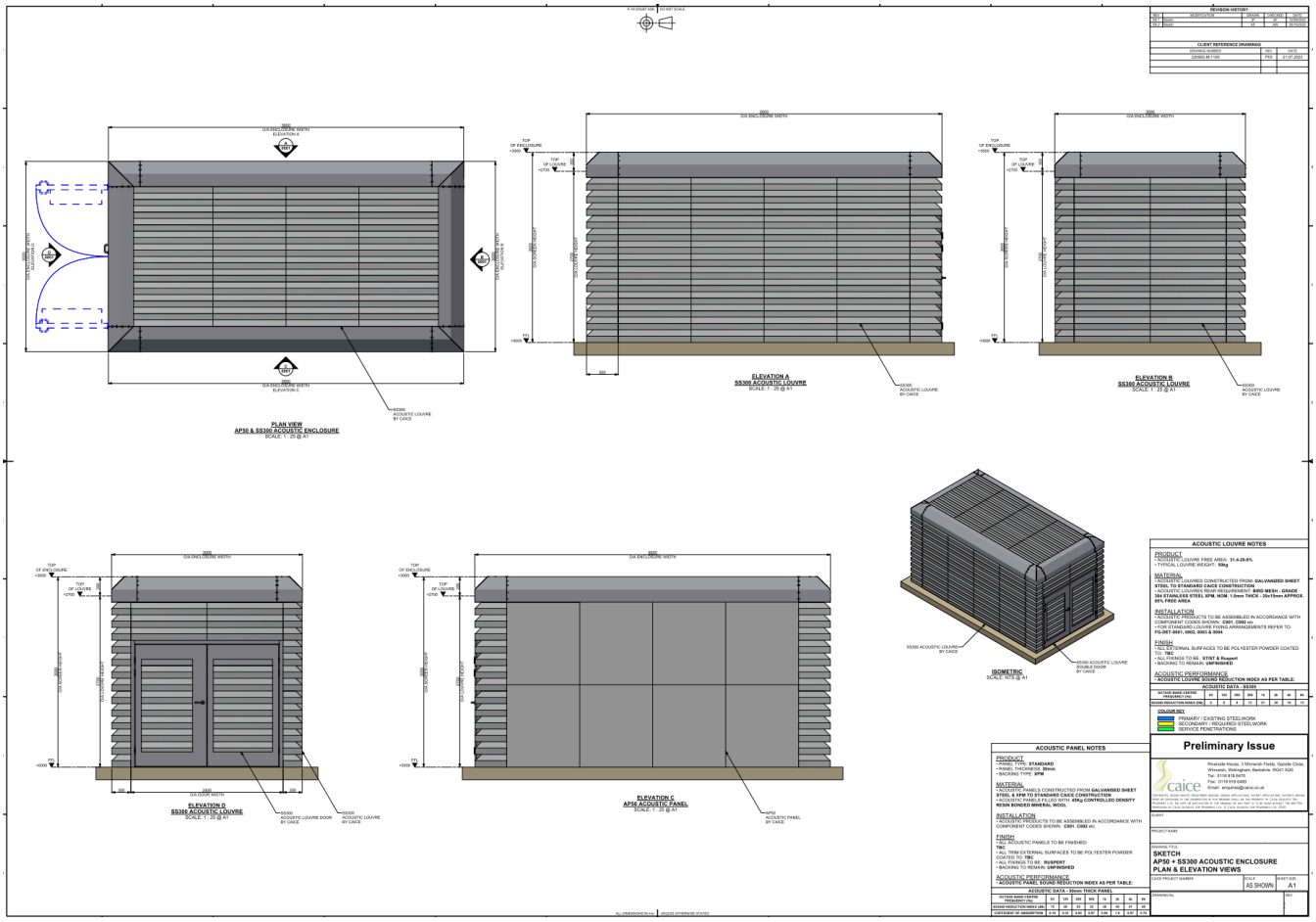
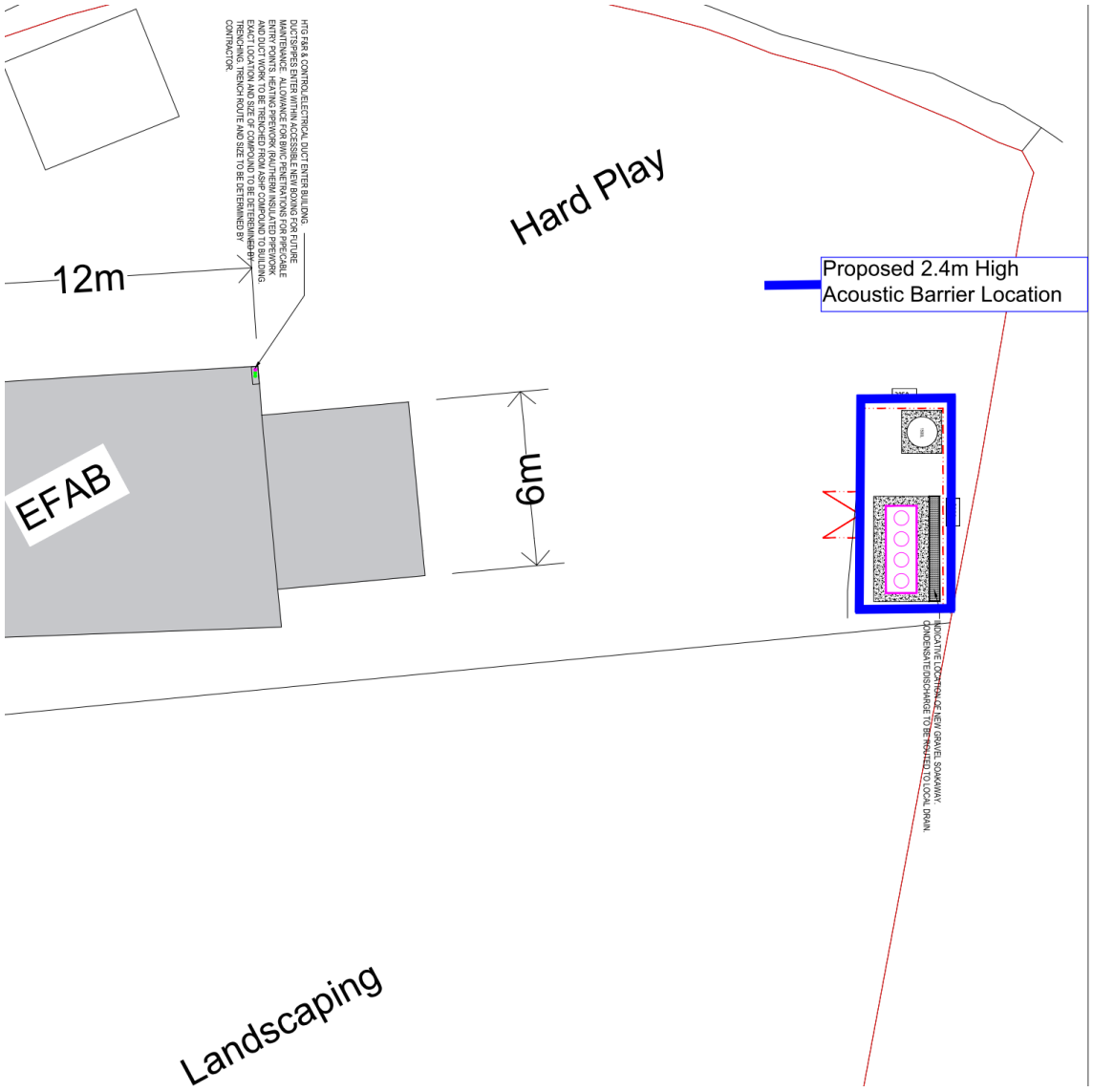


FIGURE 3. IMAGE SHOWING GENERAL FORM OF THE PROPOSED ACOUSTIC ENCLOSURE



The final design of the acoustic enclosure may vary to the one shown above.

FIGURE 4. PROPOSED ACOUSTIC BARRIER LOCATION



APPENDIX A1: ACOUSTIC TERMINOLOGY

Ambient noise	The sound pressure level at a given location (i.e. sound from all sources) usually measured using the L_{Aeq} parameter.
A-weighting	A weighting applied to the frequencies which make up a sound pressure level to mimic the response of the human ear which is less responsive to low frequency sounds as it is to high frequency sounds. The resultant level after application of the weighting is called the 'A-weighted sound pressure level' and is denoted by dB(A) or by using a subscript A (e.g. dBL_{Aeq}).
Background noise	The noise measured in the absence of the noise under investigation usually using the statistical parameter L_{90} which represents the quietest parts of the measurement period.
Broadband sound	Sound which contains all the frequencies.
Decibel (dB)	A logarithmic measurement scale used for sound pressure levels. This scale is used because the simple use of sound pressures would be unwieldy as the range of pressures to which the human ear responds is very large. The normal threshold of hearing at 1kHz is 0dB. A level of $120dBL_{Aeq}$ is very loud (L signifies level and the A and eq are explained under A-weighting and L_{eq}). Some night club dance floors can have sound levels of around 110 dBL_{Aeq}. In the workplace the wearing of hearing protection is compulsory for staff who experience a noise level of over $85dBL_{Aeq}$ averaged over an 8-hour day and is normally used when the levels are over $80dBL_{Aeq}$ averaged over the 8-hour day. Noise intrusion levels into bedrooms (e.g. from traffic noise) are often controlled to below $30dBL_{Aeq}$ in the design of new properties (standards sometimes vary between authorities). Noise levels of below $20dBL_{Aeq}$ are very quiet and would normally only be achieved in a well designed recording studio. Although noise calculations are normally carried out using figures to 1 decimal place the results are often presented to the nearest dB as changes of a fraction of a dB are not normally perceptible even in controlled conditions.
Facade noise level	Noise level including a contribution from the reflection from a building facade, usually measured at 1m from the facade.
Free field	Noise levels with no contribution from reflections from nearby structures.
Hertz	The units used for frequency denoted by Hz, i.e. the number of cycles of pressure fluctuation per second. K used in front of Hz represents 1000 (1kHz = 1000Hz). High frequency sounds (e.g. 8kHz) are high pitched and low frequency sounds (e.g. 63Hz) are the bass notes.

L_{eq}	A parameter used to denote the 'equivalent continuous sound pressure level'. This is the sound pressure level of a continuous sound that would contain the same energy as the varying sound being measured or investigated. L_{Aeq} is the parameter used to denote the 'A-weighted equivalent continuous sound pressure level' (see A-weighting).
L_{10}	A statistical parameter often used for the measurement of road traffic noise. It is the level exceeded for 10% of the time period being considered. If A-weighted a subscript A is included and the time period can also be included in subscript, e.g. $L_{A10,\ 1hour}$.
L_{90}	A statistical parameter often used for the measurement of background noise levels. It is the level exceeded for 90% of the time period being considered. If A-weighted a subscript A is included and the time period can also be included in subscript, e.g. $L_{A90,\ 5min}$.
L_{max}	The maximum noise level which occurred during the monitoring period. $L_{Amax,f}$ denotes the maximum A-weighted sound pressure level using the fast time constant of 125ms.
Loudness	Although a 3dB increase is equivalent to a doubling of the sound power level of a sound source this increase is the minimum perceptible under normal conditions. It takes a 10dB change in noise level for it to sound roughly twice (or half) as loud subjectively.
Rating Level	A term used in BS4142. The 'Specific Noise Level' plus a weighting if the noise has certain characteristic features which may make it more disturbing.
Residual noise	The ambient noise remaining when the specific noise source being investigating is not contributing to the noise level at that location (normally measured using the L_{Aeq} parameter).
Specific Noise Level	A term used in BS4142. The L_{Aeq} noise level produced at the assessment position by the noise source being investigated over the reference time period (1-hour in the day and 15-mins at night).
SEL	Single Event Level. The total sound energy of a noise event (e.g. a train pass-by) compressed into 1 second. i.e. . the 1 second L_{Aeq} which has the same total A-weighted energy as the entire event.

APPENDIX A2: EXISTING NOISE LEVELS – SURVEY RESULTS

Daytime Noise Measurements: Location A

Table A2.1: Location A: Free field daytime noise levels Wednesday 06/09/2023

Date	Time	dBL_{Aeq}	dBL_{Amax}	dBL_{A90}
06/09/2023	14:00:01	62.1	91.4	41.2
06/09/2023	15:00:01	57.4	88.4	40.2
06/09/2023	16:00:01	51.7	75.3	36.5
06/09/2023	17:00:01	55.4	84.3	38.4
06/09/2023	18:00:01	47.6	73.4	36.1
06/09/2023	19:00:01	47.5	69.8	34.5
06/09/2023	20:00:01	41.3	66.1	29.2
06/09/2023	21:00:01	37.5	58.9	25.0
06/09/2023	22:00:01	35.0	58.3	24.4
Average		54.9	-	33.9
Highest		62.1	91.4	41.2
Lowest		35.0	58.3	24.4
Mode		-	-	*

* Insuffcient data to calculate mode

Table A2.2: Location A: Free field daytime noise levels Thursday 07/09/2023

Date	Time	dBL_{Aeq}	dBL_{Amax}	dBL_{A90}
07/09/2023	07:00:01	49.0	67.6	39.4
07/09/2023	08:00:01	50.1	75.0	39.4
07/09/2023	09:00:01	53.7	76.4	44.4
07/09/2023	10:00:01	64.1	88.5	46.9
Average		58.7	-	42.5
Highest		64.1	88.5	46.9
Lowest		49.0	67.6	39.4
Mode		-	-	39

Night-time Noise Measurements: Location A

Table A2.3: Location A: Free field night-time noise levels Wednesday 06/09/2023 – Thursday 07/09/2023

Date	Time	dBL_{Aeq}	dBL_{Amax}	dBL_{A90}
06/09/2023	23:00:01	35.9	58.9	22.9
06/09/2023	23:15:01	27.5	52.2	23.8
06/09/2023	23:30:01	24.7	40.8	22.7
06/09/2023	23:45:01	25.4	36.4	22.5
07/09/2023	00:00:01	25.2	37.5	22.6
07/09/2023	00:15:01	27.4	53.6	22.9
07/09/2023	00:30:01	23.5	47.0	21.2
07/09/2023	00:45:01	34.7	51.6	23.3
07/09/2023	01:00:01	27.5	52.1	22.7
07/09/2023	01:15:01	24.5	44.9	22.9
07/09/2023	01:30:01	25.5	36.6	23.4
07/09/2023	01:45:01	28.5	50.1	25.6
07/09/2023	02:00:01	28.8	46.6	26.7
07/09/2023	02:15:01	37.0	69.8	27.9
07/09/2023	02:30:01	30.1	39.1	27.4
07/09/2023	02:45:01	29.4	44.3	27.0
07/09/2023	03:00:01	33.3	56.6	25.5
07/09/2023	03:15:01	30.5	44.8	28.1
07/09/2023	03:30:01	31.1	54.3	27.0
07/09/2023	03:45:01	30.2	40.2	27.8
07/09/2023	04:00:01	30.0	50.1	26.7
07/09/2023	04:15:01	29.4	44.3	26.7
07/09/2023	04:30:01	27.8	37.3	24.9
07/09/2023	04:45:01	34.4	55.0	28.2
07/09/2023	05:00:01	37.1	57.1	26.2
07/09/2023	05:15:01	39.9	63.8	28.1
07/09/2023	05:30:01	46.3	62.6	33.1
07/09/2023	05:45:01	50.5	76.8	34.8
07/09/2023	06:00:01	49.7	65.7	38.3
07/09/2023	06:15:01	48.1	67.6	36.1
07/09/2023	06:30:01	50.5	72.2	36.1
07/09/2023	06:45:01	50.8	73.9	37.0
Average		42.7	-	27.2
Highest		50.8	76.8	38.3
Lowest		23.5	36.4	21.2
Mode		-	-	23